in which this sense appears to be present. It is popularly believed to occur in members of at least two orders of Insects, viz. white ants and bees, but I am not aware that any authentic cases have been recorded. Horses and cats seem to possess it in a high degree, and sheep must either have wonderful memories, or owe their return, in numerous cases, to the faculty in question. Still more wonderful, if we deny them this faculty, must be the memory of migratory birds, some of which return, after months of absence and over thousands of miles, to the same nests in successive seasons. If we allow them this faculty it is not, from analogy, improbable that migratory mammals and even fishes are likewise endowed with it. The most conspicuous example, however, is perhaps that afforded by carrier pigeons. To take one case: two or three years ago some of these birds were flown from the Crystal Palace to Brussels, and it stands, if I remember correctly, upon the authority of Mr. Tegetmeier, that they arrived within a few minutes of a telegram despatched from the Palace at the moment they were liberated. Now, in this case, even the extravagant supposition sometimes made that carrier pigeons are guided by the sight of their destination is excluded, for, as these birds are not high-flyers, the curvature of the earth between London and Brussels would prevent them from seeing the latter. And, even if we imagine that these particular pigeons occasionally towered to obviate this difficulty, yet the curvature of the intervening clouds would have imposed another quite as effectual.

There is still one important point which has not been noticed during the discussion of this subject. We possess indications that this sense of direction, like other mental capacities, admits of cultivation by exercise, and, indeed, that it may remain altogether latent and useless until thus developed. If these indications represent generalities we have at once an adequate explanation of the apparently capricious manner in which this faculty occurs.* As this communication is already too long, I shall here be brief.

It is, I believe, a recognised doctrine among fanciers that carrier pigeons, however purely bred, must be educated by flying short distances before they can be depended upon for long ones. I remember having myself lost a valuable bird by flying him, for the first time, at a distance of 500 yards from his nest. Although in full view of it he became utterly confused, taking long flights in various directions, and ultimately went straight out to sea.

Here is an analogous case in a mammal:—I kept a terrier, of highly intelligent parentage, enclosed in a yard with high walls from the time of its birth until it was eighteen months old, and then took it out for the first time, along the sea-shore. The experiment elicited several facts of psychological interest, and one of them has bearing upon the present subject. Part of the coast over which we went and returned was rough with large shingle, and the terrier's locomotive power being very limited, it was unable, on the homeward journey, to keep up with my pace. Desiring to see what it would do if left alone, I continued for half a mile, and waited to see it come up. As it did not do so, I returned, and found that the animal had actually reversed its direction and gone fully a quarter of a mile from the place where I had left it. After having been taken out short distances seven or eight times, it was inadvertently lost in a neighbouring wood. Now, it had only been in the wood once before, yet its appreciation of direction had made so great an advance that it returned an hour afterwards. As this terrier never evinced any disposition to track footsteps, I do not think its return was due to scent. Anyhow, in a few weeks it became an inveterate wanderer, roaming over the country far and wide. GEORGE J. ROMANES

Dunskaith, Ross-shire, July 7

Comte on the Survival of the Fittest

MR. JEVONS called attention some time ago to the desirability of preparing a list of past thinkers and writers who have held, in strength or weakness, the doctrines of Darwin and Spencer. Mr. Darwin has himself named a few of those authors, and Prof. Haeckel has extended the number. Recent communications in NATURE show that the list is as yet incomplete. In reading Comte's "Cours de Philosophie Positive" a few years ago, I was impressed with the general similarity of certain doctrines therein stated with some of Darwin's theories. Referring recently to the 42nd lesson of that course (t. iii.)—"Considerations générales sur la philosophie biotaxique," I find that Comte, in reviewing the Lamarck-Cuvier controversy, says:—

"Toute la célèbre argumentation de Lamarck reposait finalement sur la combinaison générale de ces deux principes incontestable, mais jusqu'ici trop mal circonscrits: 1°, l'aptitude essentielle d'un organisme quelconque, et surtout d'un organisme animal, à se modifier conformément aux circonstances extérieures où il est placé, et qui sollicitent l'exercise predominant de tel organe spécial, correspondant à telle faculte devenue plus nécessaire; 2°, la tendance, non moins certaine, á fixer dans les races, par la seule transmission héréditaire, les modifications d'abord directes et individuelles, de manière à les augmenter graduellement á chaque génération nouvelle, si l'action du milieu ambiant persévère identiquement. On conçoit sans peine, en effet, que, si cette double propriété pouvait être admise d'une manière rigoureusement indéfinie, tous les organismes pourraient être envisagés comme ayant être, à la longue, successivement produits les uns par les autres, du moins en disposant de la nature, de l'intensité, et de la durée des influences extérieures avec cette prodigalite illimitée qui en coûtant aucun effort à la naïve imagination de Lamarck." (1st ed. "Cours de Philosophie Positive," t. iii. pp. 560 and 561.)

Modification and heredity are here strongly asserted, and the conditions of unlimited transformation as strongly sketched. In continuance of the same argument, Comte, on p. 563, objects to Lamarck's hypothesis, of which he thought very highly as a logical effort:—

"Qu'il repose, ce me semble, sur une notion profondément erronée de la nature générale de l'organisme vivant. Sans doute, chaque organisme determiné est en relation nécessaire avec une système egalement déterminé de circonstances extérieures, comme je l'ai établi dans la quarantième leçon. Mais il n'en résulte nullement que la première de ces deux forces co-relatives ait dû être produite par la seconde, pas plus qu'elle n'a pu la produire: il s'agit seulement d'un équilibre mutuel entre deux puissances hétérogènes et indépendantes. Si l'on concoit que tous les organismes possibles soient successivement places, pendant un temps convenable, dans tous les milieux imaginables, la plupart de ces organismes finiront, de toute nécessite, par disparaître, pour ne laisser subsister, que ceux qui pouvaient satisfaire aux lois générales de cet équilibre fondemental; *c'est probablement d'après une suite d'éliminations analogues que l'harmonie biologique a dû s'établir peu à peu sur notre planète, où nous la voyons encore, en effet, se modifier sans cesse d'une manière semblable.* Or, la notion d'un tel équilibre général deviendrait inintelligible et même contradictoire, si l'organisme était supposé modifiable a l'infini sous l'influence suprême du milieu ambiant, sans avoir aucune impulsion propre et indestructible."

The struggle for existence and the survival of the fittest or natural selection are here acknowledged. What is more, the fact that the eliminations due to unfitness for the environment or medium have produced and is producing biological harmony, is pointed out. I have not met with any passages outside of the writings of the new school, which are more explicit than these, though it must not be understood that their author was a transformationist. The preface to the volume in which this occurs is dated "Paris, le 24 Février, 1838." In his general table appended to the sixth volume of his work, Comte says that the Leçon from which these extracts are taken was written between the 9th and 15th of August, 1836. J. D. BELL

New York

The Glacial Period

CAN you inform me if anyone has suggested the following explanation of the existence of the glacial period? And is the explanation I am about to offer a possible one? I put the question in all diffidence, for I have not carefully studied the theory of heat: you must therefore regard any utterance of mine on the subject as merely "a random arrow from the brain." Well, then, it seems to me that the quantity of heat given out in a unit of time from a unit of surface of an intensely heated globe, such as the sun, does not follow the law of radiation of bodies moderately heated. What I mean is this:—It is quite possible that at a time when the sun's mean temperature was higher than it is now, his rate of radiation might have been less; the quantity of heat emitted by him in a unit of time less than it is now. For since his chromosphere must have been thicker, and his solid or fluid nucleus somewhat less in diameter, I suppose that the radiation of the nucleus must have been more retarded by the

---

* In connection with these points compare the suggestive remarks of Mr. Darwin, contained in the two concluding paragraphs of his article on Instinct (NATURE, vol. vii. p. 418).

© 1873 Nature Publishing Group

chromosphere than is at present the case. It is true, that owing to the increased pressure at the surface of the nucleus due to a thicker chromosphere, the temperature there may have been a little higher; but I do not think that difference would make up for the increase in absorption of the chromosphere.

Assuming then that the sun gives out more heat now in a given time than he did during the glacial period, and that the earth had already so far cooled down that her surface was not sensibly more warmed by internal heat than it is in our own epoch, the mean temperature of the earth's climate would have been lower, and the sea-level line of perpetual snow nearer the Equator in both hemispheres; and glaciers would have covered vast tracks of country which are now denuded of them.

Again, let us go back some millions of years in the world's history, till we arrive at the carboniferous period. The sun then would probably be emitting less heat than even during the glacial period; but the earth would not have cooled down to such an extent, and her internal heat would be sensible at the surface. The mean climate of the globe would have probably been warmer then than it is now, and the temperature more equally distributed, depending not so much on solar as on terrestrial radiation. This being supposed, the vegetation of England and India in those days must have presented less difference than what we find at present. Does the flora of our English and Indian coal-beds support or upset this conclusion? Can any of your correspondents answer this query, or set me right if I am wrong in my hypothesis of solar radiation?

Hampstead, July 22 J. H. Röhrs

P.S.—Is there any good mathematical treatise on heat, English or French, up to the latest information on the subject? Can you or any of your correspondents recommend me such a treatise?

Telescope Tube for Celestial Photography

I HAVE not yet seen any satisfactory plan suggested of getting over the difficulty experienced in celestial photography by the expansion and contraction of telescope tubes, by changes of temperature in metal tubes.

I therefore venture to suggest the following plan, which may be so arranged as to keep the object-glass and camera-slide *exactly* the same distance apart, and so keep the true focus when once found. The arrangement would have to be modified according to the metal of which the tube is made, but taking a brass one (the most common), with the camera attached to the eyepiece-slide, the correction will be effected by attaching to the main tube, near the eyepiece, two zinc rods the length of the main tube, upon which they must rest loosely; to the free ends of these, near the object-glass, attach a rod of iron extending to the eye-tube; let this iron rod be attached to the eye-tube when the sensitive-plate is exactly in focus; any change in temperature will then have no effect on the focus, for the expansion and contraction of the three metals will keep the distance from object-glass to sensitive-plate constant. All who have worked with a telescope giving sharp definition, will know that this is not an unnecessary precaution, as it may seem to some.

Sydney Observatory, June 14 H. C. Russell

Colour of the Emerald, etc.

I HAVE to beg "A. H." to refer again to NATURE (July 24) p. 254, col. 1, line 23, where he will find it stated that "the emeralds employed were canutillos from Santa Fé de Bogotá. Their specific gravity was 2·69." It is evident, therefore, that they could only be the green silicate of alumina and glucina.

The green sapphire, known also as the "oriental emerald," is the rarest of all gems; and Mr. Harry Emanuel, in his work, "Diamonds and Precious Stones," speaking of it says, "In the whole course of my experience I have only met with one specimen." Its specific gravity would at once distinguish it from the true emerald.

The Beryl A. was colourless, opaque, and had a specific gravity of 2·65. Greville Williams

INSTINCT, PERCEPTION, AND REASONING POWER OF ANIMALS

THE correctness of the following facts, bearing on the above question, I can warrant:—

A beautiful greyhound bitch in my possession had puppies, and I gave one of them, about a month old, to a friend of mine who was also living in Montpellier at that time. Some few days subsequently, on going to call at my friend's house, I took the greyhound with me. She appeared delighted at finding her puppy again, and expressed her strong feeling by lavishing on it, in her own way, the most tender marks of affection. After a few days I paid a second visit to my friend (unaccompanied by the greyhound), when he informed me that, in consequence of the earnest request of one of his friends, he had been induced to give him the puppy, which had thus been removed to a considerable distance. I returned home, and on my arrival was struck with the peculiar manner in which the animal met me. There was nothing of her usual expression of delight—no barking, no jumping to and fro—but she met me with a serious and thoughtful look, and began slowly to smell my clothes in different places, with the most earnest perseverance. Nor was she content with a mere cursory effort to discover the particular object, whatever it was, which, no doubt, she had in view; but she continued the same course of proceeding for at least a quarter of an hour, in fact, till I found it quite necessary to bring it to a close.

From the above statement of the conduct of the animal, the impression on my own mind was that I must have carried away from my friend's house some subtle effluvia, which tended to bring back to the mother the recollection of her puppy. And this caused me some additional surprise, inasmuch as greyhounds are possessed of great keenness of sight, but are generally considered as rather deficient in their power of smelling. The conclusion is still more remarkable. During the space of about two years I usually paid my friend a visit twice a week, and on every occasion, on my return home, the greyhound would invariably go through the same ceremony. At length the proceeding became altogether so striking that it was quite unnecessary for my wife and family (perhaps from a little innocent curiosity) to ask, "Where have you been?" They could save themselves the trouble of a question and say "I see that you have been calling on your friend."

My cousins were residing in a small village about thirty kilom. from Montpellier, and on one occasion, when I was going to spend some days with them, I took, for the first time, my greyhound with me. It so happened that not far off there was a hound bitch that belonged to one of my cousins' neighbours, and between these two animals (from the beginning of my short stay) there arose the deepest hatred and animosity, and conflicts of the most ferocious kind were matters of daily, almost hourly, occurrence. Time altogether failed in producing any better feeling between them, and to the end of my visit each was ever ready and anxious to try their strength whenever the opportunity offered. In the course of the following year I paid a second visit to the same place, accompanied by my greyhound, and about three-quarters of an hour before I reached the village the animal, as if struck with a sudden idea, rushed forward at her full speed, and all attempts to call her back proved quite ineffectual. On reaching the village I found that a terrible encounter had already taken place between the two heroines, who were on the point of renewing the attack after a temporary cessation of hostilities.

The following anecdote relating to the same greyhound seems to prove that these animals may sometimes exhibit a higher standard of reasoning power than according to general opinion they possess.

I was passing some days in the country with my aunt, who had a middle-sized spaniel bitch, of a somewhat sullen and treacherous temper. This spaniel observed, with an evident feeling of jealousy, that my greyhound was making herself quite at home in my aunt's kitchen, and whenever she had a favourable opportunity, without

© 1873 Nature Publishing Group